

The Woodwright's Guide

Working Wood with Wedge & Edge

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Illustrations by Eleanor Underhill

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Introduction

My favorite comic book—snatched from Mark Olshaker's stash and read by flashlight under my blanket at summer camp—was *Atomic Knights!* In its post-Armageddon world, underground survivors dared not risk walking Earth's radioactive, rubble-strewn surface. Not, that is, until scientists discovered that old suits of armor would somehow protect the wearers from the still-lethal atomic radiation. Thus, our heroes, the Atomic Knights, ventured forth from the shelters to battle re-emergent evil, armed with swords, safely clad in suits of ancient iron.

Since then, I've learned to recognize the archetypal myth of redemption by ancestral spirits. In myth, it's always a sword, never a chisel. Still, it's the woodworking blade that got us here today. The things we create and the ways we work matter to this ever smaller planet. A world that doesn't end with a communist bang can still go down with a consumerist whimper.

The working blade cuts deep into our history. An old axe or chisel likely contains iron that has been recycled since Roman times. The iron wedge and steel edge and the grain of wood are still with us. We still use a wedge to split the wood, exploiting the planes of weakness in the grain—paradoxically capturing its strength. We still use an edge to shear the wood, exposing the beauty of the grain, shaping it to our desire. Wedge and edge—obvious at times, sometimes working unseen and side by side, just as they have for thousands of years.

This book's journey begins in the forest and passes through each woodworking trade as it moves farther from the tree. We go from forest to furniture, from green to dry, from risk to certainty, nature to culture, outdoor to indoor, multiple hernias to carpal tunnel syndrome. I describe the tools and connections as they arise in each working environment. Thus, once the technique of drawboring a mortise and tenon joint is introduced in the carpenter's work, it reappears as a known quantity in joinery and cabinetmaking.

I revisit here many of the techniques that I discussed in earlier books. I hope I have explained matters with greater clarity and presented fewer idiosyncratic methods. Over the years, I've had the opportunity to watch some true masters at work. To paraphrase Isaac Newton, "I have looked over the shoulders of giants." I'll try to get out of the way as much as I can and let you see for yourself.

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Cleaver & Countryman

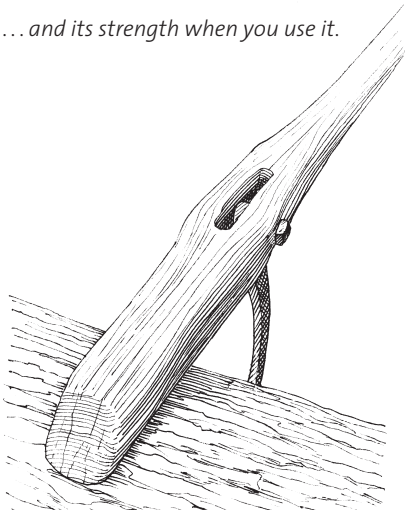
*When frost will not suffer to dyke and to hedge,
then get thee a heat with thy beetle and wedge:
A short saw, and long saw, to cut a-two logs,
an axe, and an adze, to make trough for thy hogs;
A grindstone, a whetstone, a hatchet and bill,
with hamer, and english naile, sorted with skil;
A frower of iron, for cleaving of lath,
with roll for a sawpit, good husbandrie hath.*
—after Thomas Tusser,
Five Hundred Points of Husbandry, 1557





Exploit the weakness of the grain when you work wood ...

... and its strength when you use it.



Oak billets for the shingle maker.

Clearing land, splitting fence rails, shaving shovel handles, bending oxbows—there are few aspects of woodworking unfamiliar to the countryman. He fells the hickory, splits it and shaves it to make a chair, strips its bark to weave the chair bottom, and sits in it by a fire fueled by the limbs. The faller may never hold a plane; the cabinetmaker may not know where wood comes from—the countryman sees it all.

It begins in the grain of the wood. We learn to exploit the weakness of the grain when we work wood, and to exploit the strength of the wood when we use it. Wagon spokes, chair rungs, hayforks—anything where strength is essential—all are riven from the log. Sawing would take more energy and investment. Worse, it ignores the path of the grain, too often cutting across it. Sawn stock—weaker and costlier. Riven stock—cheaper and stronger.

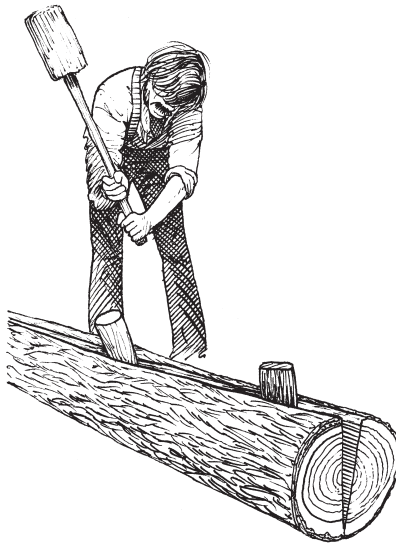
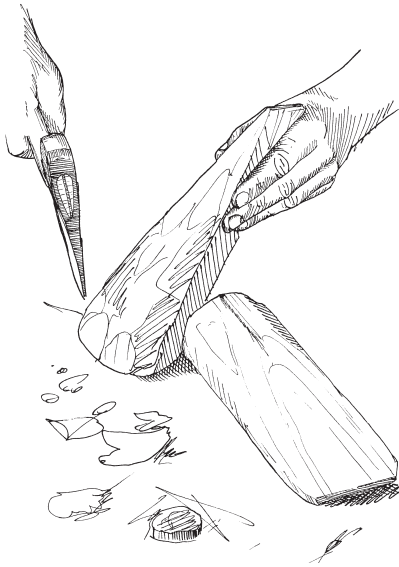
Splitting wood makes the tree a partner with you. I found the best expression of this partnership in a cant hook I bought at a farm auction. The shaft of the cant hook was shaved from a riven billet of white oak, exploiting the weakness of the wood. The split followed the grain, ensuring that all the strength of the wood was captured within the shaft.

The riving also revealed a knot near one end of the stave. A knot (a branch overgrown by the tree) is usually considered a weak point in a piece of wood—but that is true only for sawn timber. As the tree grows outward, it swallows the branch with the grain flowing around it like a river around a rock. The straight path of a saw knows nothing of this and cuts through the flow of the grain. Splitting, however, followed the grain and left a bulbous section around the knot. The maker of the cant hook followed the grain as well, putting the hole for the iron hook right in the middle of the flow.

In riving, you usually split a piece in half, then split that piece in half, and so forth. Halving each piece helps the split run straight—as long as the grain is straight. Often it's not, but because wood and bark are made in the same layer in the tree, you can usually tell the book by the cover. If the bark spirals, so too will the wood within.

Oaks, tulip poplar, hickories, ash, chestnut, pine, cypress, walnut, cedar, and basswood are among the most cooperative splitters. All of them split more easily when the wood is fresh. Of course, if it's an elm or a gum log you're looking at, forget it.

Splitting is not without hazards to health and hardware. Considering all the times I've hit steel wedges with a steel sledge, I'm going to hell for sure. The steel sledge on the steel wedge gradually work-hardens the head of the wedge so that one fatal strike can send shrapnel flying. A worse sin is using the head of an axe to drive a serious wedge. This quickly bows out the thin eye of the axe and destroys it. Using the axe head as a wedge and driving it with a heavy sledge has the same effect. If your axe is the only wedge you have with you, a good roundhouse swing at the end grain of a short log might split it or might start a split that you can advance with another well-placed strike with the axe or more proper splitting tools.



LEFT: The beveled striking head keeps the glut from splintering.

RIGHT: A hickory root maul drives dogwood wedges to split a red oak log.

Beetle and Wedge

You'll need an axe or a steel wedge to start a split, but once it's begun, you can continue the split with gluts—wooden wedges chopped from any hard, tough wood. Gluts can't have quite as much taper as a steel wedge, but they can be made much longer. You can use a two-foot-long glut to great advantage on a big log.

The poet says, "Get thee a heat with thy beetle and wedge." "Beetle" is the Old English word for a mallet to pound anything from pavement to laundry. You may work up a sweat, but the beetle takes a beating. Tough elm makes a good beetle head, and binding it with iron rings will keep the edges from chunking off.

This kind of mallet with a separate head and handle makes for an end grain striking face, but what of the one-piece maul where the striking face is side grain? One-piece mauls for driving wedges are often called root mauls, because you make the striking head from the underground part of the tree. All those roots radiating from the base of the stem act to peg the striking head together and buttress the faces with their end grain.

A root maul is not something you can buy. Find a tough hardwood tree about five to seven inches thick at the ground. Dig away the dirt, chopping the roots as you go. Once it's uprooted, clean it well and chop it into shape. Shape the wood while it is green and soft, but let it dry before you put it to hard use. For a two-handed maul, the head might be about ten inches long and the handle twice as long as that.

Froe

You'll need a smaller version of the root maul to use with your froe. The L-shaped froe leads two lives as a splitting tool. As you drive it into the wood, it



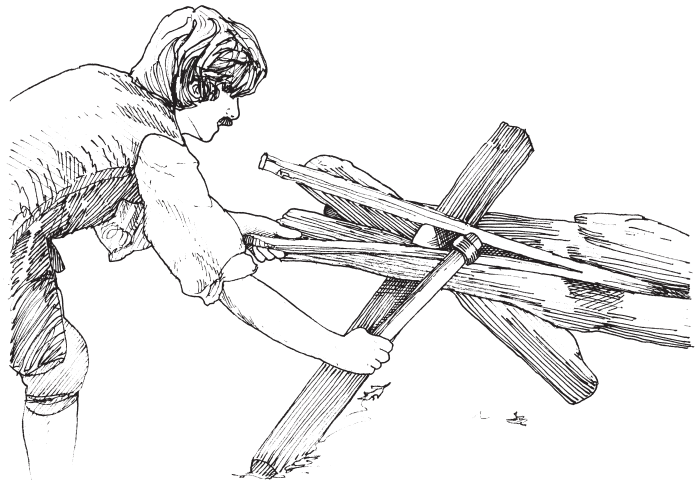
As long as both pieces bend equally...

... the plank can split straight.

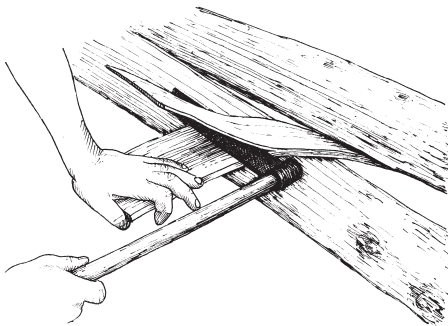




Bend the thicker side against your knee to keep the split straight...



...or use a riving break made from the crotch of a tree.



Push down on the thicker side to bring the split back to the center.

acts as a wedge. Once sunk in the end, when you pull back on the handle, the blade acts as a lever to pry the two pieces apart.

You'll need to set the wood into a notch of sorts before you pull back on the froe, because the splitting action works only if the wood can't twist or skid away. You can also do this with your body, inclining the wood away from you while bending your knee against it. With the bottom of the wood against the earth, and the middle against your knee, the froe can do its work.

Like a canoe down the rapids, the split is going to go with the flow of the grain. But just as you can guide the canoe from side to side, so too can you guide the split. The split will tend to run to the side that bends more. Bent fibers are pulled and weakened; thus, the thinner side, bending more, tends to get thinner and thinner, and the split "runs out." You can direct the split by deliberately bending one side more than the other. With the froe in one hand, your free hand does the steering. Set the thicker side against your knee and pull back on the top. Flip the piece around and bend the other half as necessary, keeping the split running down the middle.

On long splits, you can stand on the piece and pull up on the thicker end. When you need to do a lot of such work, though, make a riving break from a closely forked limb. The gap should be less than a foot or so—and the more parallel the branches of the fork, the better. The fork needs to lie horizontally, somewhat more than knee high. The bottom of the fork can just sit on a

stump, but the far end gets two timbers set through it in an X. The X wants to collapse, but the fork constrains it—like this: ✕.

Now you can push down on the froe handle, with the sides of the riving break replacing your knee and the ground. You can more easily steer the split, because you can push down with your weight on the thicker side. Flip the board as needed to keep the thickening side down and the split running true.

Repeating this thousands of times in a day's work, the countryman shingle maker exploits the planes of weakness in the wood, and a tree becomes a roof. The froe is the essential wedge of the shingle maker. Shingles fresh from the froe may need trimming, a job for the hatchet's edge.

First, though, why do the shingles need trimming? Oak shingles, split radially from the log, carry a band of white sapwood on one edge. Sapwood is the living wood of the tree just under the bark. After a few years, as more fresh wood has grown outward, the aging sapwood builds up natural preservatives and becomes heartwood. In some trees, like hickory and sycamore, the heartwood has little color change and gains hardly any resistance to decay. In other species like oak, cedar, and walnut, the color and durability change is profound. Sapwood, however, has no resistance to rot. In oak shingles exposed to the weather, it has to come off with the hatchet.

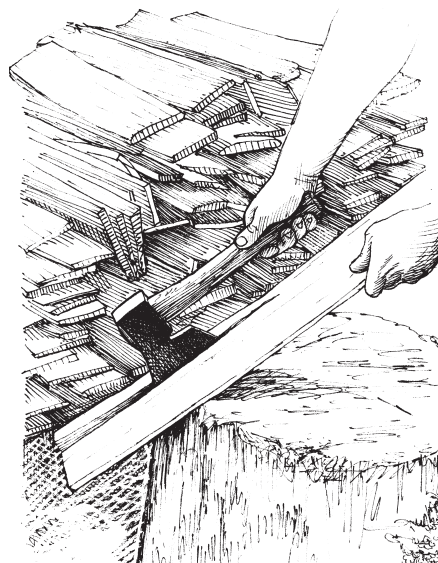
Shaving Horse

Leverage is a handy thing. In the froe, it splits the wood. In the shaving horse, it grabs the wood. The shaving horse is a foot-operated vise that allows you to hold a piece of wood while you sit and shave it with a drawknife or other tool. The earliest image I know of a shaving horse is in a 1500s-vintage German mining textbook. The horse is fully formed, with accompanying drawknife—more evidence of its German origins. Even in the New World, the shaving horse is commonly called a “schnitzelbank,” from the German “cutting bench.”

The beauty of the shaving horse is that the more you pull with your arms, the harder you must push with your feet. The harder you push with your feet, the harder the jaw grabs. The grip of the vise may be instantly released by removing foot pressure, allowing the piece to be quickly repositioned.

Bodger's Horse

Although grounded in the same principle, there are two sorts of shaving horses. The more common one is the solid-headed horse used on the Continent and in America, as well as by coopers everywhere. But in British woodland crafts, they more often use a bodger's horse. Here, the foot lever and grip is a rectangular frame fitted around the bench and the sloping work surface. The bodger's horse is shorter and lighter—a good thing, because it was carried into the beech forest by the bodger. There, the bodger split billets of beech, shaved them down, and turned them into chair legs on a spring-pole lathe. At



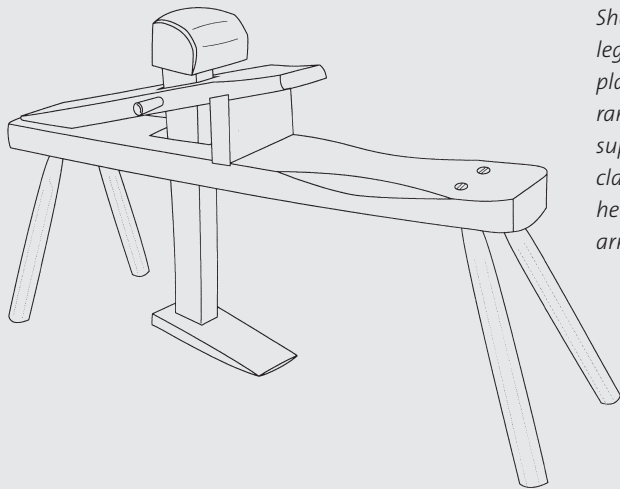
Split off the sapwood with the broad hatchet.



A shaving horse with a solid head.



The bodger's horse.

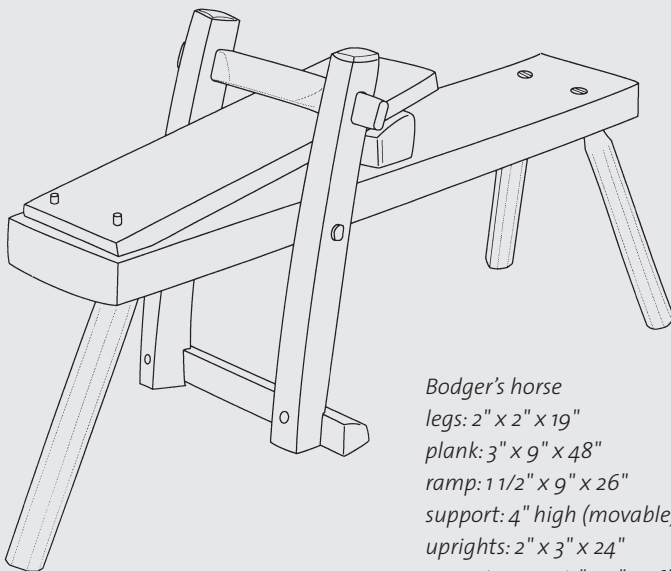


Shaving horse
 legs: 2" x 2" x 19"
 plank: 3" x 9" x 60"
 ramp: 1 1/2" x 9" x 30"
 support: 6" high
 clamp overall: 31" long
 head: 6" x 6"
 arm: 2" x 3"

Two Shaving Horses

This horse lets you shave with the drawknife's keen edge, as you sit on it's back split from logs with a wedge, which you rive out by breaking the grain that is weak that flows through the oak like gray hair in a streak. The legs fit in holes in the plank like a stool, each fixed with a wood wedge that follows this rule:

When setting the legs, fit the wedge 'cross the grain of the plank that you sit on, its strength to maintain. When shaving, you'll see that the harder you draw, the more your horse bites on the wood in its jaw. And though your fine horse won't win any races, your seat on its back is the best of all places.



Bodger's horse
 legs: 2" x 2" x 19"
 plank: 3" x 9" x 48"
 ramp: 1 1/2" x 9" x 26"
 support: 4" high (movable)
 uprights: 2" x 3" x 24"
 crosspieces: 1 1/2" x 2" x 16"

the end of a season, the bodger carted his legs to town and sold them to chair makers. Never made a chair, just the legs.

Drawknife

Combined with the shaving horse, the drawknife lets you put all the strength of your arms, legs, and back into long strokes with a razor-sharp blade. The handles that you use to pull the knife along the surface also give you precise control over the angle of the blade, allowing you to cut deeply or finely. The drawknife is still a free and open blade, often taking a middle role in creating a shape—the piece first being chopped, then drawknifed, then planed to final smoothness. The work goes quickly. Sitting on a shaving horse with a good drawknife in your hands, you can get to talking with someone, look down, and find that you've made a chair by mistake.

Unlike pocketknives with two equal bevels, and unlike chisels with one flat and one beveled edge, drawknives often split the difference. The upper side of the blade may have the only visible bevel, but the apparently flat side often carries a slight bevel—just enough to give you some depth control. New drawknives are often dead flat on one side, and when the flat is against the wood, you have control only when cutting convex surfaces. Flip the drawknife over to cut with the bevel down, and you again have control over the depth of cut. Drawknives are so different in their bevels, curvature, and handle angles that you need to get to know them individually.

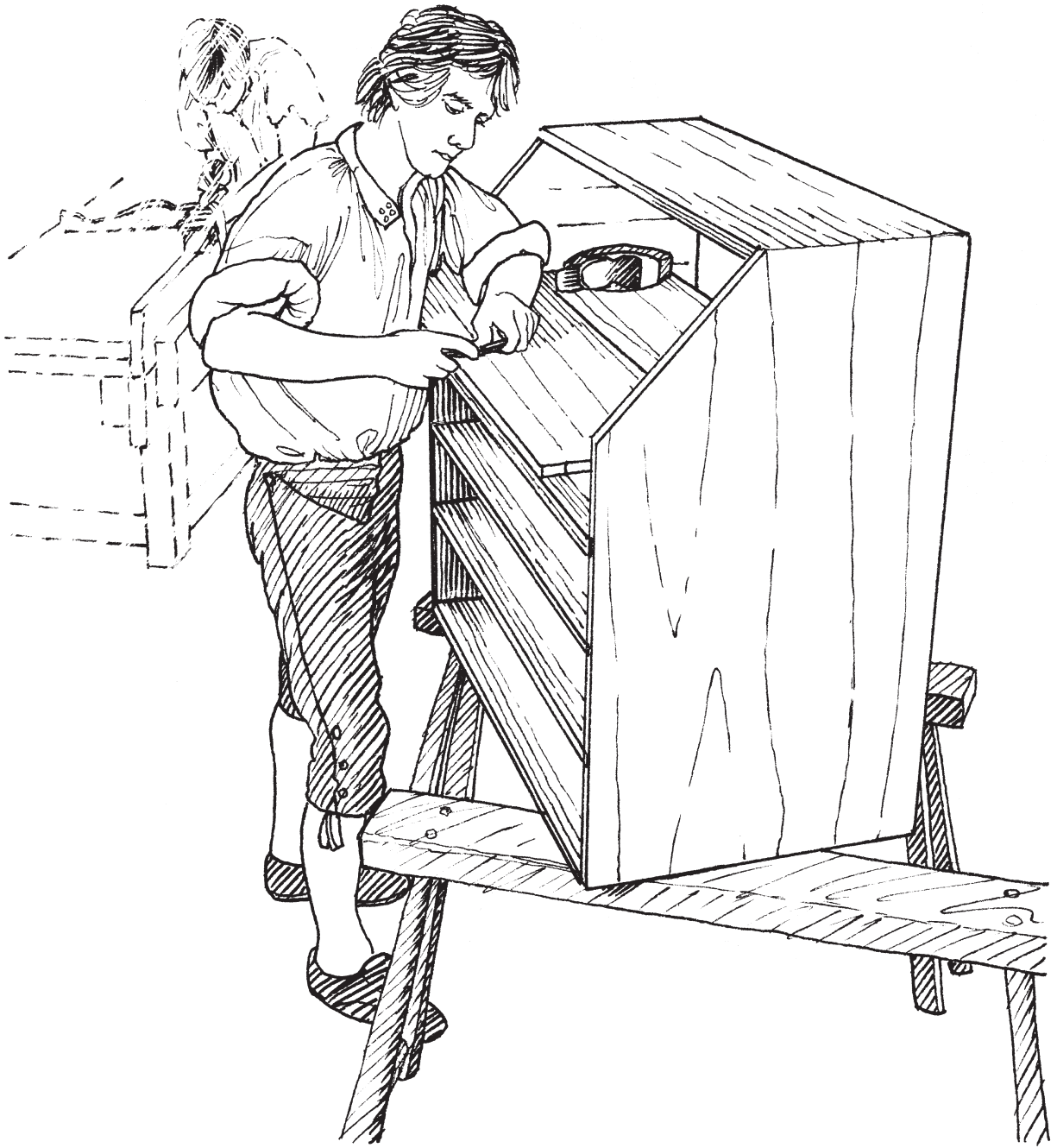
If you hold it diagonally to the direction of the pull, any drawknife can work with a shearing cut. This lowers the slope of the upper bevel—a mixed blessing. A lower bevel slope makes a sharper edge, but also a thinner wedge. And this increases the chances of splitting the wood.

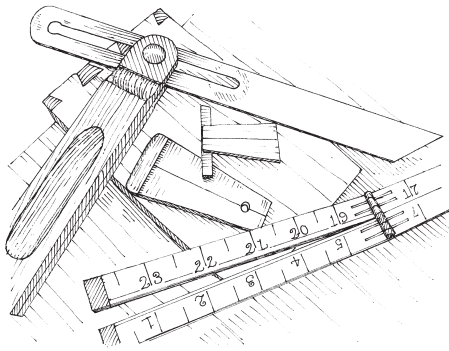
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Cabinetmaker

[Cabinetmaking is] joinery of a superior description, working with finer tools on more costly woods, and producing more sightly effects.

—Mechanics' Own Book, 1885





Dovetail markers and a sliding bevel.

Cabinetmakers seem like such nice people, but who cuts the walnut's crotch and exposes its storm-stressed flames in a window of polished shellac? Who stuffs balls into the claws of beasts and makes them into a chair leg? Even the gnarliest burl is helpless as they saw it into slices, level it with toothed scrapers, and choreograph the pieces into a symmetrical dance. Cabinetmakers capture wild natural beauty and cage it within classic geometry—yet they hide their own sweat within secret joints that show nothing of the inner connections.

In Georgian cabinetmaking, the slightly effect was to reveal the wood but conceal the joints. Contemporary cabinetmaking comfortably reveals both. Dovetails give you that choice. They can be fully exposed, half-hidden, or kept secret. Dovetails are fundamental to cabinetmaking, but wood is wood, and the mechanics of joining it spans all the trades. Now, the multiple-dovetail joint has transcended even its functional identity to become the icon of handcraft in wood.

But the mechanics never go away. When you pull out a drawer, you see splayed dovetails on the sides and trapezoidal pins on the end grain of the drawer front. You certainly could make a dovetailed drawer with the tails on the front and the pins on the sides, but such a construct would orient the weakness of the joint in the same line as the greatest load. Dovetails are the strongest of joints, except in one direction.

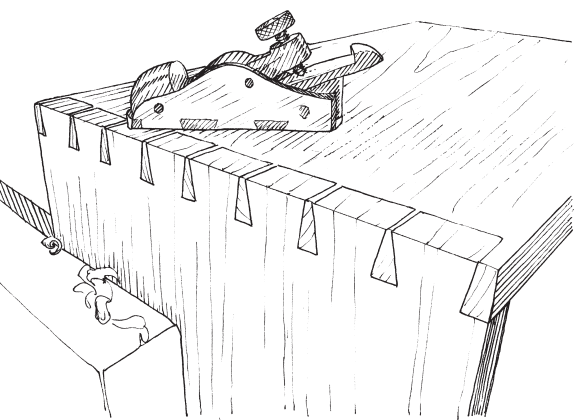
So, first, consider mechanics, even if you let aesthetics make the final decision. Second, how much joint do you want exposed? A Charleston desk joined with secret miter dovetails shows no joint at all. A Shaker desk with through dovetails shows joints at all corners. In their drawers, however, they all look the same, both pieces joined with half-blind dovetails. We'll take each of these joints in turn, starting with a through dovetail for a chest.

Through Dovetail—Tails First

Dovetails are cut by superimposition. I wrote earlier about laying out mortise and tenon joints by superimposing one element on the other and transferring dimensions. This makes some people uncomfortable. Good cogs in the mass production machine are supposed to work from a measured drawing, manufacturing each precise part and then fitting them all together. But try to find a measured drawing from the days of the great cabinetmakers—there are none. Their forms emerged from the constraints of classical proportion, customer demand, and mechanical necessity. They built furniture largely with superimposition shaping each piece of the emerging whole.

The immediate question for dovetails is, which do you cut first? Which part gets to be the super of the superimposition, the tails or the pins? In secret miter dovetails, we have to cut the pins first, so that's settled. But we're making through dovetails now, so we'll do the tails first.

The wide boards of this chest will have lifting handles on the end. Thus, the tails will go on the sides and the ends will get the pins. Dovetailing can be



Planing the ends of the tails on the through dovetail joint.

no more precise than the boards are square and true. Square all the end grain with a block plane, leaving it smooth to allow clear marking.

Assuming you are joining equally thick boards, set the gauge $1/32$ inch greater than the thickness of the boards and run the fence of the gauge against the end grain of each of the boards to mark the extent of the tails and pins. This extra $1/32$ inch gives you something to plane off the completed joint. Lightly trail the point of the gauge across the grain rather than scratching and tearing. A lightly held cutting gauge serves even better.

Now decide the spacing of the tails and pins. If the chest has any skirting around the base or lips to meet the lid, consider their locations so the dovetails won't begin or end awkwardly. If the boards will have a groove plowed down their inside to hold a bottom, that groove should not overlap the joint between a tail and pin. Make these grooves first so they won't be a surprise later on.

To fight confusion, I'll call the piece with the tails the tail board, and the one with the pins the pin board.

We will cut the tails first, meaning we are working on the broad sides of the chest and defining the sockets for the pins between the tails, the pin spaces. Custom demands that dovetails end on a half-pin, although you may find otherwise in old pieces.

The size of the pins relative to the tails is an aesthetic/mechanical tradeoff. For a heavy chest, you could make them equal in size, but even when equal spacing would be stronger, a chest looks far better when the pins are about half as wide as the boards are thick, and the tails are about three times as wide as the pins.

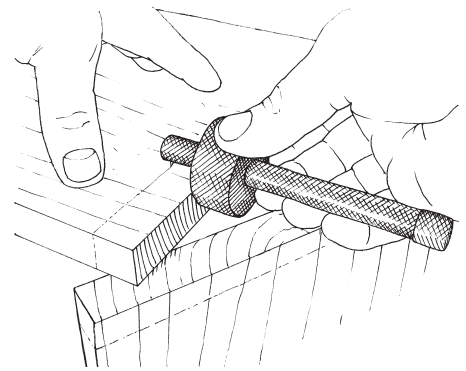
By this guideline, the thickness of the wood determines how many tails and pins will fit within a given width. For $3/4$ -inch-thick, 11-inch-wide boards, this comes to 8 dovetails separated by 7 pins, bounded by a half-pin on each end. We thus need to divide the 11-inch board into 8 equal spaces—not measuring from edge to edge, but from the centerline of one outer half-pin to the centerline of the other.

At their widest points, these half-pins should be the same width as the full pins, at least half the thickness of the wood, in this case, $3/8$ inch. This puts their centerlines at $3/16$ inch back from the edges. (If you think the corners are going to take a beating, you can make the bounding half-pins a bit wider.)

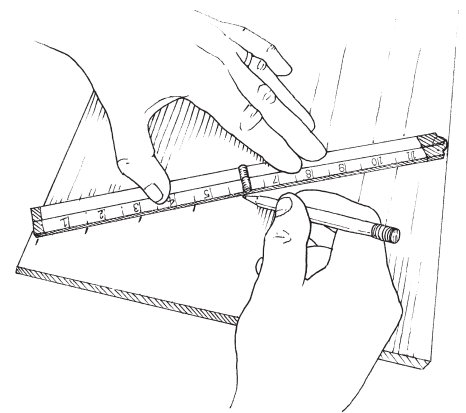
Back to dividing an 11-inch board into 8 equal spaces. Hold a ruler diagonally on the board with the 0 end crossing the centerline of one half-pin and the 12 crossing the centerline of the other. Put a pencil mark every $1\frac{1}{2}$ inches down the diagonal ruler. Carry these marks up to the end using a try square and a pencil, dividing the width into 8 equal parts.

This works for any width or number of divisions. You would place a mark every 2 inches if you wanted to divide the board into 6 equal parts. For 7 equal parts, position the ruler at 0 and 14 and mark every 2 inches. For 5, go to 15 and mark every 3.

Anyway, where each pencil line crosses the line marked by the gauge, mea-



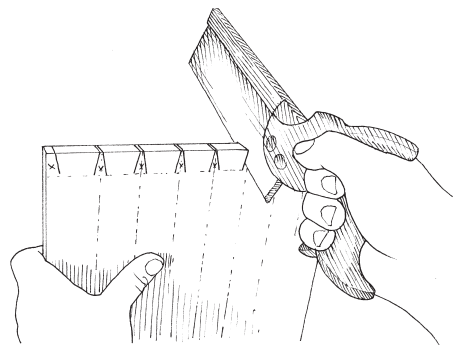
Gauge each piece to its mate's thickness, plus $1/32$ inch.



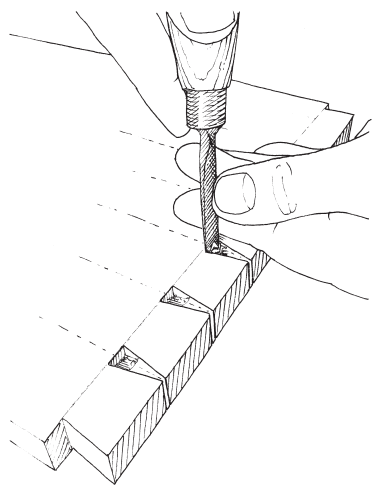
Divide the width into equal parts using a diagonal ruler.

RIGHT: Set the sliding bevel for an angle of 1:6.

LEFT: Lay out the spaces between the dovetails.

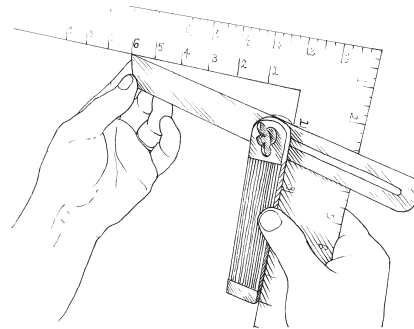
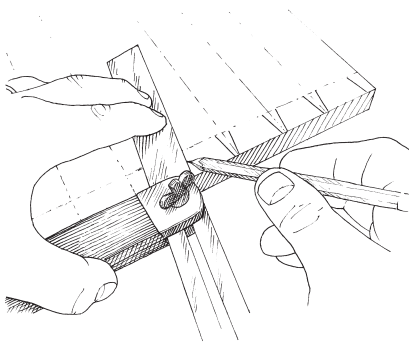
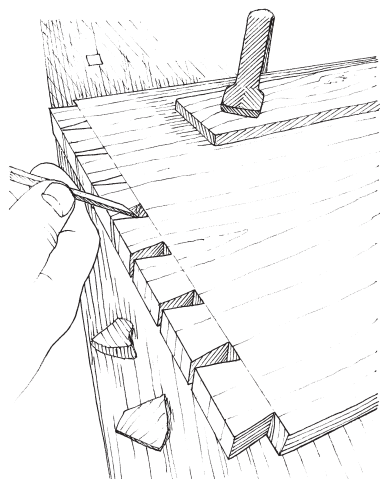


Saw the sides of the waste spaces.



Chisel down from one side ...

... and complete from the other.



sure out the width of the pin space, $\frac{3}{16}$ inch on either side for a total of $\frac{3}{8}$ inch. This is the widest part of the pin space, the narrowest part of the dovetail, and the slope starts here.

For most work, find the slope angle for your dovetails by setting the sliding bevel to cross the one and the six inches on the square. A one-in-five slope looks more robust; a one-in-seven looks more delicate.

Whatever angle you decide upon, set the beam of the sliding bevel on the end grain and draw the converging sides of the pin spaces up from the gauged line with a sharp pencil. Mark the little spaces with Xs so you will know what you will be cutting away. Carry all these lines square across the end grain and use the bevel again on the back side. The lines across the end grain are the most important. You can have variation in the slopes between different dovetails—they'll just look funky. But if the lines aren't sawn square across the end grain, the assembled joint will have gaps that weaken the whole works.

Sawing at last. A dovetail saw is simply a fine-toothed backsaw, but use what you have. Saw precisely parallel to the lines, touching them but leaving them intact. Saw diagonally at first and watch that you leave the line on both faces.

The ends where the half-pins fit will come off with two more cuts from the saw, but the rest of the pin spaces need chisel work. You could remove most of the wood with a coping saw or, in heavy work, use an auger, but normally this is all push chisel work. If the pin spaces are $\frac{3}{8}$ inch wide at their base and taper down from that, the largest chisel you can use is one about $\frac{5}{16}$ inch wide and beveled on the sides because you need to start away from the scribed line.

Try working with two chisels, starting by pushing straight down with the wider chisel, flat face to the line. Then, with the narrower chisel held bevel down, push toward the bottom of the first cut and remove a chip. Working down, excavate halfway through. Flip the board over and make the same V-opening to meet the first one. Leave the narrow end intact to support the waste until the V-cuts meet—otherwise it might break out and tear the wood. Clean up and trim the pin sockets back to the line.

Now we'll cut the pins to fit into these sockets.

See that the board for the pins is not cupped, clamping a batten onto it if necessary to hold it flat. Set it in the vise as you hold the end grain flush with a piece of scrap or a plane lying on its side. Push this scrap or plane back across

the bench to support the back end of the tail board, the super board of the upcoming superimposition.

Align the board bearing the tails on the end of the pin board. See that you are well and truly aligned to the scribed line with the extra 1/32 inch hanging over. A pencil can't reach into the tiny pin spaces, so scribe the width of the openings onto the end grain of the pin board with a knife, cutting dead flush to the walls of the sockets. Don't let the board move until they are all marked.

Remove the tail board and elevate the pin board enough that you can carry the lines square down to the depth mark with the try square. Mark the waste pieces with penciled Xs. You are now about to remove big pieces and leave small ones. Accurate sawing on the waste sides of these lines will make the joint fit without trimming. Split the lines with the edge of your saw kerf, and the whole should fit up fine.

The waste from the broader sockets for the dovetails is broad enough to make the rough cut with a coping saw worthwhile. Work from the face side with the teeth cutting on the pull stroke. It may be that your coping saw cuts a wider kerf than the dovetail saw, so keep it pulled to the waste side as you work your way down to make the turn across the grain.

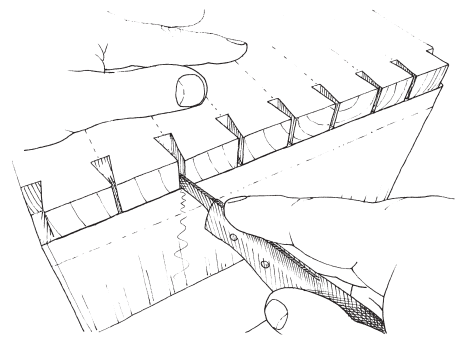
The broad bottoms of these sockets for the tails form visible parts of the joint and need to be straight and clean. Lay the piece on a scrap block on the bench and pare toward the middle with the freshly sharpened chisel set right in the depth line for the final cut. Finally, you stand the piece up in the vise again and shave with a diagonal shearing cut of the chisel to smooth the bottom.

Test the fit. Don't bevel the ends of the pins to make the fit easier—you've got only 1/32 inch to play with. Instead, pare back the hidden, inside corners of the dovetails. This beveling strengthens the edges of the tails and gives a little clearance for any stuff in the corners. Watch for a fat fit that could cause a split, particularly against the half-pins at the ends. Use a cabinet rasp to trim if you need to, but mind its corners.

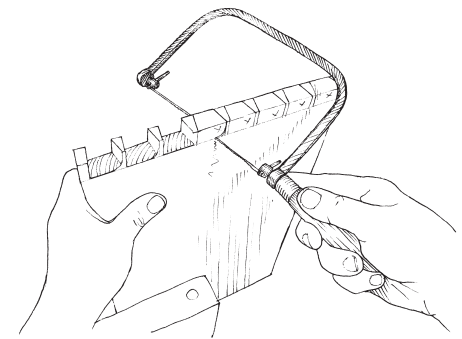
Set a batten across all the tails to spread the impact and protect the tails as you drive them up with the mallet. You may want to use bar clamps to draw the joint up instead. First time out, bring the joint all the way closed before tapping it apart, applying glue and re-closing and squaring it. With more experience you can just make a partial test fit before gluing. After the chest is joined and the glue fully set, trim the protruding ends of the tails and pins with a block plane, working from the outside in so you don't splinter off any ends.

Through dovetails in plain flat boards are the simplest expression of the joint. In practice, there are complications.

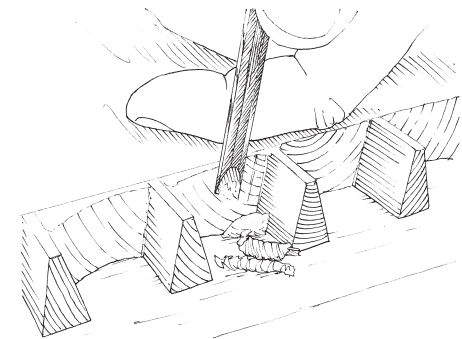
If you have a groove on the inside of the chest, you must leave an extra shoulder at the bottom of the dovetail socket to fill the wood removed by that groove. This makes a shallower, slightly weaker and odd-looking joint. You may be better off stopping your grooves short of the ends of the chest so the dovetails can remain whole.



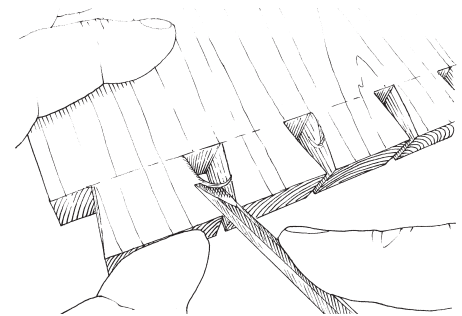
Set the tails on the joining board and mark the pins.



Cut the sides of the pins with a dovetail saw, and remove the waste with a coping saw.



Chisel flush to the gauged lines.



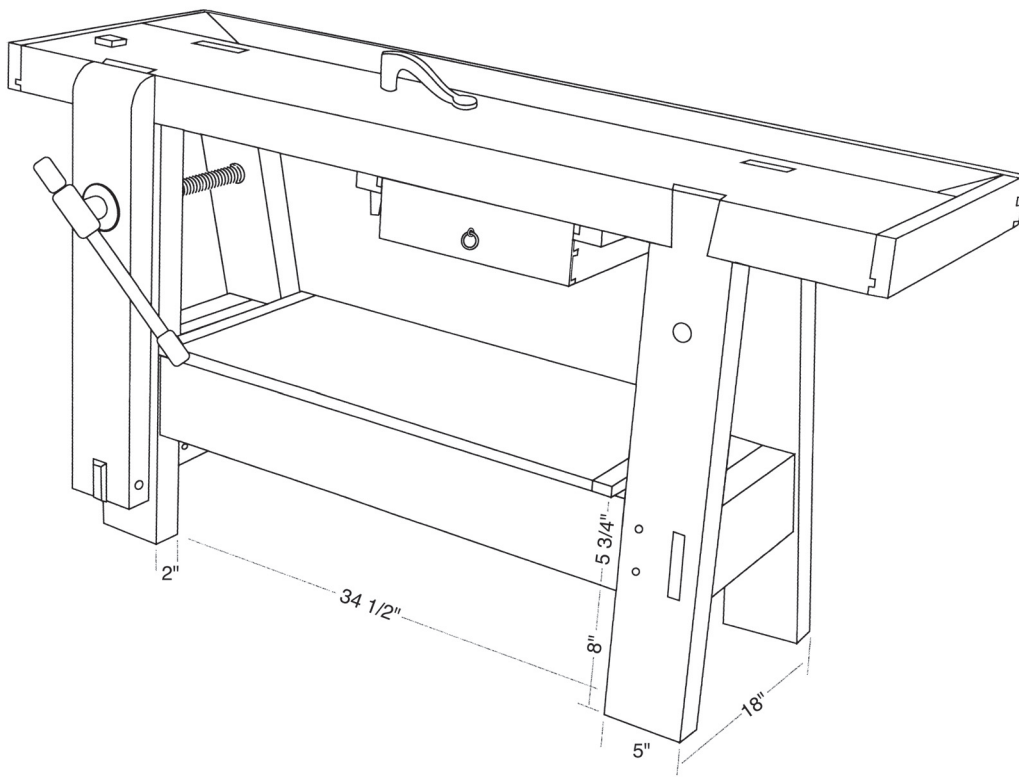
Bevel the inside corners of the dovetails.

Plans

C. A Roubo Bench

The common workbench of André Roubo's time was a single massive plank sprouting four legs. I say "sprouting" rather than "supported by" because this form of bench uses "stool" rather than frame construction—more like a Windsor chair than a table. The version I describe here, fitted with a toolbox with a locking lid set between the stretchers, is based on one I saw in the town of Isle sur la Sorgue in southern France. Simple as it is, this is a challenging bench to make. The timbers are big—hard to find and hard to work. The joints are big too, yet require precise fitting. Done right, though, it's a workbench beyond compare.

When trees were big, so were benches. Old benches, with tops six inches thick and two feet wide, could stand stable on perpendicular legs. As available timbers for the top narrowed, however, perpendicular legs would make the bench too tipsy. But, just like a Windsor chair, narrower-topped benches can regain their stability by splaying out their back legs. These splayed back legs solve one problem but present another. The back legs intersect the top at



an angle, with their tenons fitting into mortises angled through the top. The front legs, however, are perpendicular. Having the front and back legs come in at different angles poses no assembly problem when they are independent pieces, but here they are joined by the broad stretchers. In a Windsor chair you can assemble the converging pieces—legs, top, and stretchers like a car wreck played backward, driving each joint tighter as you go. You can build this bench that way, but I propose you try a more amusing solution, letting the court jester of joints rescue the old king of benches.

If you look at the dovetails connecting the front legs of the bench to the top, you'll see that they slope in two directions, both up and down and in and out. This means that the legs can never pull down; nor can they pull out to the front. The advantage of this style of dovetail is that it can never come apart. The disadvantage is also apparent—it can never go together.

Or so it seems. This is the rising dovetail joint. It's usually found only in puzzles, fooling us by hiding its slope while letting us continue to think at right angles. The rising dovetail is just a normal dovetail tenon (or pin) tilting toward us. The tenon is at an angle to the length of the leg and to the edge of the bench top. This exposes an oblique slice that appears wider at the end and makes the rising dovetail look impossible to assemble. In our case, however, the rising dovetail makes the bench easy to assemble, because it goes together at the same angle as the sloping back legs. The rising dovetails make it possible to join the bottom frame entirely and then drop the top on with a backward sliding motion.

Start with the top of the top. You want the hardest, thickest, widest piece of wood you can get, but you use what you have. I usually work with oak, but for this bench I lucked onto a plank of hard maple, three inches thick, ten inches wide, and ten feet long. I decided that two, five-foot-long benches would be more useful to me than one longer one. I'm glad I chose as I did, because the five-foot version is almost too much for me to move. The two front legs and front stretcher are also hard maple. The back legs and stretchers are soft maple, which saved money and made the work a little easier.

A flat workbench top is the foundation of everything that you make upon it. In this case, the flat bench top is also the starting point for everything made below it. You level the top, true the front edge, and build on from there. Leveling a great, wide piece of rough-cut hard maple is no joke. You may need a good bit of adze work before using the planes as I describe in Chapter 7. Roubo recommends that you orient the grain of the bench with the heart side up. This ensures that further seasoning will cause the top to crown rather than hollow. Once you establish the flat plane of the top and the perpendicular front edge, you build downward from there to the floor.

The rising dovetail is the second challenge. Our brains struggle to describe three-dimensional work arranged at right angles, and fail utterly when it comes to describing these angled intersections. Even after you've cut one of these joints, you're still not quite sure what you've done. If you have not cut one before, practice on cheaper stock, following the steps illustrated. The di-

FIGURE 1

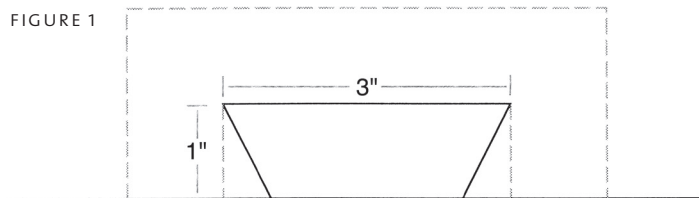


FIGURE 2

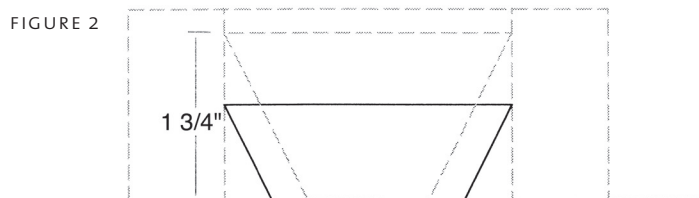


FIGURE 3

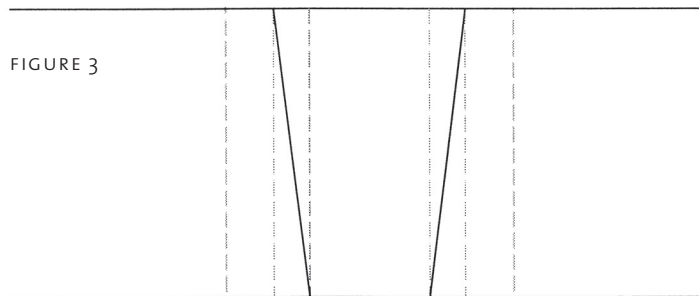


FIGURE 4

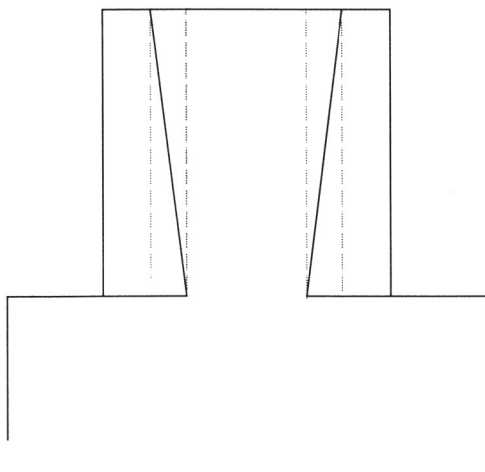


FIGURE 1. View looking down at the bench top. A glance at the dimensions of the dovetail socket tells you that the slope is one in two—very bold.

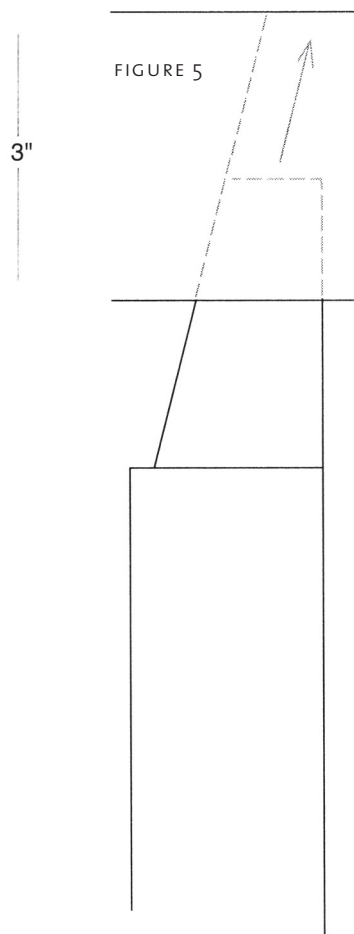
FIGURE 2. Still looking down at the bench top. The dotted line shows the dovetail opening on the underside. This opening has the same width and slope as the upper one, but it sits deeper ($1\frac{3}{4}$ inches) into the bench top.

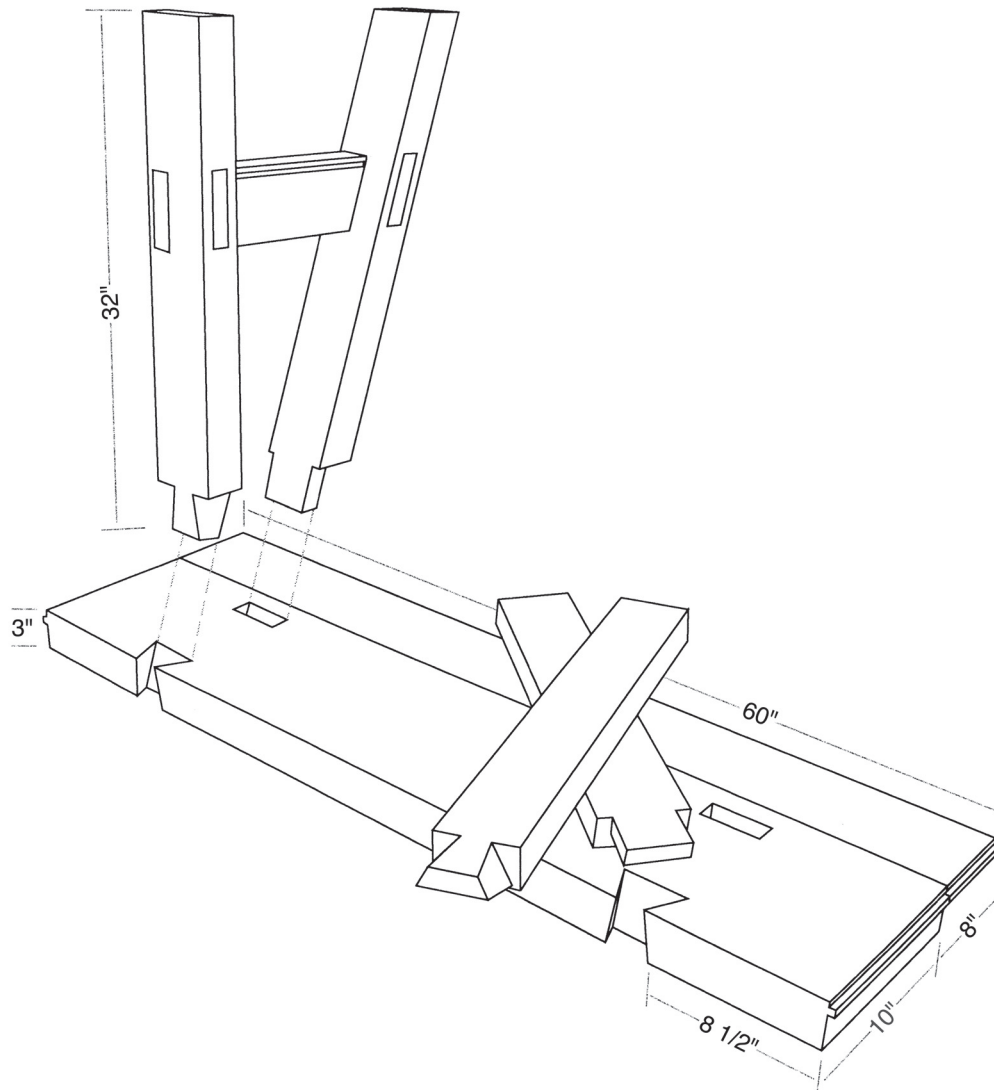
FIGURE 3. View of the face edge of the bench top. Connect the top and bottom dovetail socket openings with straight lines. Saw and chisel out the waste.

FIGURE 4. The dovetail tenon in face view.

FIGURE 5. The path of the tenon as it slides up into the socket to fill it. Making the lower dovetail opening $\frac{3}{4}$ inch deeper than the top creates a 1:4 angle that matches the angle of the back legs.

The back slope of the dovetail is $\frac{3}{4}$ inch in 3 inches, a ratio of 1:4. The back legs splay 8 inches out of plumb in 32 inches, also a ratio of 1:4.





mensions given in the drawing create a slope equal to that of the back leg, making assembly easier.

The back legs have straight tenons with beveled shoulders. They fit into angled mortises, bored and chiseled through the bench top. In this case, the angle of the mortise is easy to find. The top is 10 inches wide, and the desired spread at the feet is 18 inches, so this puts the back legs 8 inches out of plumb. Since the total height from floor to bench top is 32 inches, the splay of the back legs is 8 in 32, or, 1 in 4. Set your bevel to this angle and use it to draw the passage of the mortise on the end grain of the top. Bring these lines across the face and underside to locate the actual mortise. Using the same 1:4 setting on your bevel, use it to guide your auger as you bore down from the top face of the bench.

In spite of all your care in truing the stock and fitting, the front legs may need a slight push or pull to bring them dead perpendicular to the top. The back legs give you something to push or pull against. Fit all the legs as accurately as you can, drive them into place, and bring the front legs square by

either pulling together or spreading apart the feet of each pair. With the legs thus wedged or clamped, hold the stock for the stretchers against them and mark them to fit. French workbenches typically have a shelf for tools set in between, or on top of, the stretchers. The stretchers on this bench are wide enough to fit a floor into grooves plowed around their lower edges. Add a lid, and you have a tool chest. A drawer under the top is also handy, and the one in the Roubo illustration is fitted with a lock as well.

Once the legs and stretchers are joined, stand the base upright, set the top on, and start the tenons into the mortises. Rather than pound on the top to drive the joints home, lift and drop alternate ends of the bench on a stout floor, letting the mass of the top drive itself down. The top will move three inches down and 3/4 inch back as the dovetail tenon rises to fill its space.

The solid, level floor required for this mode of assembly also serves when leveling the bench. Shim up the legs to bring the top level, and use a plumb bob and string to check the front legs as well. You can level the top with more planing, but you can't as readily correct the plumb of the front legs. When it looks level, find the leg with the widest gap between it and the floor, set your dividers to this gap, and scribe it around all four legs. Move the bench to a different spot on the floor and repeat the leveling and scribing before you trim the feet to the scribed lines—the floor may not be as level as it looks.

Now that you're up on your legs with that nice workbench top, it seems a shame to lose any part of it. Still, the bench top has to sacrifice a bit of length to create the tongues to support the frame of the tool well. Use a fillister plane followed by a rabbet plane to take down the ends of the top, leaving a 3/8-inch-square tongue to fit into the matching groove plowed into the skirt boards. This groove in the skirt boards continues all the way around the inner face of all three pieces to support the bottom of the tool well. The back edge of the bench top also gets a groove at the same level to support its side of the tool well bottom.

The flat, heavy top is the foundation, but you still need something to hold the wood against it. You can always sit on the wood for mortising, but for planing and sawing, you need a bench stop, a vise, and some holes for the holdfast. Bore and chisel the mortise for the bench stop—the square sectioned block that you tap up and down to catch the ends of boards as you plane them. Get the holdfast in your hands and try its fit in a test hole before you bore any holes in the bench. Augers are graduated in 1/16-inch increments, and making the hole that much too big means forging another, larger holdfast. This form of bench is best suited to take a front leg vise. A two-by-five-inch leg is fine for an iron screw, but not quite stout enough to take a large wooden screw, so *bœuf* it up as you see fit.

